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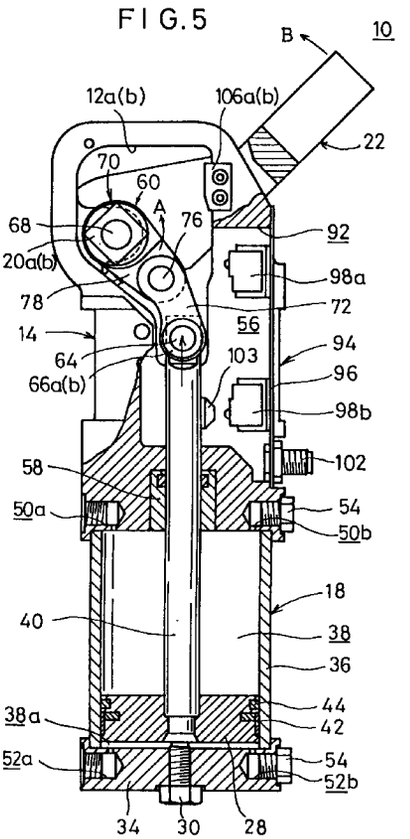
(54) Fluid driven clamping device

(57) A cylinder apparatus comprises a body (14) having a flat rectangular parallelepiped shape, a cylinder unit (18) for accommodating a piston (28) which is reciprocatable along a cylinder chamber (38), a toggle link mechanism (60) for converting linear motion of a piston rod (40) into rotational motion, and an arm (22) for making rotation by a predetermined angle in accordance with a driving action of the cylinder unit (18), wherein reaction force-receiving plates (106a, 106b) for absorbing reaction force (H) applied when a workpiece (W) is clamped are detachably provided in the body (14).

FIG.5



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Description

BACKGROUND OF THE INVENTION

Field of the Invention:

The present invention relates to a cylinder apparatus capable of clamping a workpiece by the aid of an arm which is rotatable by a predetermined angle in accordance with a displacing action of a piston.

Description of the Related Art:

When components of an automobile are welded, for example, a cylinder apparatus has been hitherto used to clamp such a component. The cylinder apparatus is disclosed, for example, in USP 4,905,973 and DE 29504267 U1.

The cylinder apparatus disclosed in USP 4,905,973 and DE 29504267 U1 comprises a main body which is constructed by integrally assembling a pair of casings formed to be substantially symmetrical to one another, a cylinder unit which is connected to the main body, and an arm which is rotatable by a predetermined angle in accordance with a driving action of the cylinder unit by the aid of a toggle link mechanism provided in the main body.

The cylinder unit is provided with a piston which is reciprocatively accommodated in a cylinder tube, and a piston rod which is connected to the piston. The toggle link mechanism, which comprises a bearing member for rotating the arm, is connected to a free end of the piston rod. A guide groove is formed on an inner wall surface of the casing, which functions to guide the linearly movable piston and absorb the reaction force applied when a workpiece is clamped by the arm.

A desired welding operation is performed for the workpiece while clamping the workpiece by the aid of the arm which is rotatable by a predetermined angle in accordance with the driving action of the cylinder unit.

However, the cylinder apparatus disclosed in USP 4,905,973 and DE 29504267 U1 adopts an arrangement in which the reaction force is applied to the arm when the workpiece is clamped by the arm, and the reaction force is received by the guide groove formed on the inner wall surface of the casing. In this arrangement, the wall surface for constructing the guide groove wears out due to sliding friction of the piston rod which is reciprocated integrally with the piston. Therefore, backlash or looseness occurs resulting from a gap between the piston rod and the guide groove, and it becomes difficult to rotate the arm in a stable manner. Further, a disadvantage arises in that the occurrence of backlash decreases the clamping force of the arm for the workpiece.

SUMMARY OF THE INVENTION

A general object of the present invention is to provide a cylinder apparatus which makes it possible to avoid occurrence of any backlash resulting from the reaction force generated when a workpiece is clamped so that the an arm may be rotated in a stable manner.

A principal object of the present invention is to provide a cylinder apparatus which makes it possible to exclude the decrease in clamping force resulting from the backlash.

Another object of the present invention is to provide a cylinder apparatus which makes it possible to mutually and conveniently reassemble the cylinder apparatus of the right arm type into the cylinder apparatus of the left arm type.

The above and other objects, features, and advantages of the present invention will become more apparent from the following description when taken in conjunction with the accompanying drawings in which a preferred embodiment of the present invention is shown by way of illustrative example.

DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a perspective view of a cylinder apparatus according to a first embodiment of the present invention.

FIG. 2 shows a partial exploded perspective view of the cylinder apparatus shown in FIG. 1.

FIG. 3 shows an exploded perspective view of a body for constructing the cylinder apparatus shown in FIG. 1.

FIG. 4 shows an exploded perspective view of a cylinder unit for constructing the cylinder apparatus shown in FIG. 1.

FIG. 5 shows a partial longitudinal sectional view of the cylinder apparatus shown in FIG. 1.

FIG. 6 shows a partial longitudinal sectional view illustrating a state in which an arm shown in FIG. 5 is rotated by a predetermined angle.

FIG. 7 shows a plan view illustrating a modified embodiment of the arm.

FIG. 8 shows a plan view illustrating another modified embodiment of the arm.

FIG. 9 shows a plan view illustrating still another modified embodiment of the arm.

FIG. 10A and FIG. 10B shows plan views illustrating attachment directions of a connector respectively.

FIG. 11 shows a partial front view illustrating the reaction force applied to a toggle link mechanism.

FIG. 12 shows a perspective view of a cylinder apparatus according to a second embodiment of the present invention.

FIG. 13 shows a perspective view of a cylinder apparatus according to a third embodiment of the present invention.

FIG. 14 shows an exploded perspective view of a

body for constructing the cylinder apparatus shown in FIG. 13.

FIG. 15 shows a magnified perspective view of a support lever incorporated into the cylinder apparatus shown in FIG. 13.

FIG. 16A to FIG. 16C show sectional views illustrating the procedure for reassembling the cylinder apparatus of the right arm type into the cylinder apparatus of the left arm type respectively.

FIG. 17A and FIG. 17B show partial longitudinal sectional views of a screw plug to be screwed into a screw hole provided in a bearing section.

FIG. 18 shows a perspective view illustrating a state in which the cylinder apparatus of the right arm type shown in FIG. 13 is reassembled into the cylinder apparatus of the left arm type.

FIG. 19 shows an exploded perspective view of an example in which a body is divided.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIG. 1, reference numeral 10 indicates a cylinder apparatus according to a first embodiment of the present invention. The cylinder apparatus 10 comprises a body 14 formed to be flat in an integrated manner and having a pair of mutually communicating openings 12a, 12b (see FIG. 3), a pair of cover members 16a, 16b for closing the openings 12a, 12b of the body 14 respectively, a cylinder unit 18 connected to a lower end of the body 14 in an air-tight manner, and an arm 22 connected to bearing sections 20a, 20b having a square-shaped cross section and protruding to the outside from the cover members 16a, 16b. A plurality of holes 24 are formed on a plurality of side surfaces of the body 14, for attaching the cylinder apparatus 10, for example, to another member or a wall surface.

As shown in FIG. 4, the cylinder unit 18 comprises an end block 34 and a cylinder tube 36. The end block 34 includes an elliptic recess 26 formed on an upper surface, and a screw member 30 screwed through a lower surface into a screw hole 32 for adjusting the displacement amount of a piston 28. The cylinder tube 36 is composed of a cylinder having an elliptic cross section with its one end connected to the recess 26 of the end block 34 in an air-tight manner and the other end connected to a bottom surface of the body 14 in an air-tight manner.

As shown in FIG. 5, the cylinder unit 18 further comprises the piston 28 which is accommodated in the cylinder tube 36 and which is reciprocative along a cylinder chamber 38, and a lengthy piston rod 40 which is connected to the center of the piston 28 and which is displaceable integrally with the piston 28.

A wear ring 42 and a seal ring 44 are installed to an outer circumferential surface of the piston 28 respectively. Attachment holes 46a to 46d are bored through four corners of the end block 34. The end block 34 and the cylinder tube 36 are assembled to the body 14 in an air-tight manner by the aid of four shafts 48a to 48d inserted into the attachment holes 46a to 46d. Pairs of mutually opposing pressurized fluid inlet/outlet ports 50a, 50b, 52a, 52b for introducing and discharging a pressurized fluid into and from the cylinder chamber 38 respectively are formed in the body 14 and the end block 34 respectively. When the cylinder apparatus 10 is actually used, blind plugs 54 are screwed into ones of the pressurized fluid inlet/outlet ports 50b, 52b respectively to be used in a state in which the ones of the pressurized fluid inlet/outlet ports 50b, 52b are closed as shown in FIGs. 5 and 6.

As shown in FIGs. 5 and 6, a chamber 56, which communicates with the pair of openings 12a, 12b formed on the both sides respectively, is formed in the body 14. The chamber 56 is provided so that a free end of the piston rod 40 faces the chamber 56. In this embodiment, the piston rod 40 is guided linearly and reciprocatively by a bush 58 which is fixed on a side of the lower end of the body 14 and the wear ring 42 which is installed to the outer circumferential surface of the piston 28.

A toggle link mechanism 60 is provided at the one end of the piston rod 40, for converting the linear motion of the piston rod 40 into the rotational motion of the arm 22. As shown in FIG. 3, the toggle link mechanism 60 comprises a first pin member 64 which is rotatably supported by a hole 62 formed at the free end of the piston rod 40, and a pair of rollers 66a, 66b which are held at both ends of the first pin member 64. The toggle link mechanism 60 further comprises a support lever 70 which is rotatably supported with respect to the body 14 about a second pin member 68 as a support point, and a pair of link plates 72 which intervenes between the support lever 70 and the free end of the piston rod 40 and which links the support lever 70 to the free end of the piston rod 40.

That is, each of the link plates 72 is formed with a pair of holes 74a, 74b which are separated from each other by a predetermined spacing distance. The link plate 72 is coupled to the free end of the piston rod 40 via the first pin member 64 which is rotatably supported by one of the holes 74a, and the link plate 72 is coupled to a projection 78 of the support lever 70 via a third pin member 76 which is rotatably supported by the other hole 74b. In this embodiment, the pair of bearing sections 20a, 20b each having a rectangular cross section, which protrude to the outside from the cover members 16a, 16b, are formed at both ends of the support lever 70. A depression 82, which is fitted to a protrusion 80 formed integrally with the body 14, is formed between the pair of bearing sections 20a, 20b.

Therefore, the linear motion of the piston rod 40 is transmitted to the support lever 70 via the link plates 72. The support lever 70 is rotated in a predetermined direction about the second pin member 68 as a support point.

The bearing sections 20a, 20b, which are formed at the both ends of the support lever 70, are provided so that they are exposed to the outside through holes 84 of the cover members 16a, 16b. In this arrangement, circular step sections 86, which are formed adjacent to the bearing sections 20a, 20b, are inserted and fitted to the circular holes 84 of the cover members 16a, 16b respectively to close the holes 84. Thus, the body 14 is prevented from invasion of dust or the like which would otherwise enter the body 14 through the holes 84. The arm 22 is detachably connected to the bearing sections 20a, 20b by the aid of plates 87 fastened by screws (see FIG. 2).

The arm 22 may be constructed as follows. That is, as shown in FIG. 7, a clamp section 90 may be provided at the center of a main arm body 88. Alternatively, as shown in FIGs. 8 and 9, the arm 22a, 22b may be provided with a clamp section 90 on any one of sides deviated from the center of a main arm body 88.

As shown in FIGs. 5 and 6, a hole 92 communicating with the chamber 56 is formed through a back surface of the body 14. A sensor unit 94 for detecting the amount of displacement of the piston 28 is installed to the hole 92. As shown in FIG. 2, the sensor unit 94 comprises a pair of proximity switches 98a, 98b which are fastened by screws to a substantially T-shaped plate 96 and separated from each other by a predetermined spacing distance, a pair of circular caps 100a, 100b which are detachably installed to holes provided in bent sections of the plate 96, and a connector 102 for transmitting detection signals outputted from the proximity switches 98a, 98b to an unillustrated external controller via lead wires connected to the proximity switches 98a, 98b. Alternatively, for example, unillustrated microswitches or pneumatic switches may be provided in place of the proximity switches 98a, 98b.

In this embodiment, the direction and the amount of displacement of the piston 28 can be detected by detecting a detection object 103 (see FIGs. 5 and 6) fixed at a predetermined position on the piston rod 40, by using the proximity switch 98a (98b). An operator can select any arbitrary direction from three directions to attach the connector 102 by removing the cap 100b (100a) installed to the plate 96 and installing another connector 102 (see FIGs. 10A and 10B). As shown in FIG. 3, the pair of cover members 16a, 16b for closing the openings 12a 12b of the body 14 respectively are fastened by screws. Accordingly, the cover members 16a, 16b can be attached and detached in a convenient manner.

As shown in FIG. 3, recesses 104 each having an oblong cross section are formed at upper portions of the openings 12a, 12b on the both sides of the body 14 respectively. A pair of reaction force-receiving plates 106a, 106b (reaction force-absorbing member) for engaging with the rollers 66a, 66b to absorb the reaction force are detachably fastened by screws to the recesses 104. Therefore, when the reaction force-receiving plates 106a, 106b wear out, they can be conveniently exchanged with new reaction force-receiving plates 106a, 106b after removing the cover members 16a, 16b.

The cylinder apparatus 10 according to the first embodiment of the present invention is basically constructed as described above. Next, its operation, function, and effect will be explained.

At first, the cylinder apparatus 10 is fixed at a predetermined position by the aid of an unillustrated fixing means. First ends of unillustrated tubes or pipes are connected to the pair of pressurized fluid inlet/outlet ports 50a, 52a respectively, and second ends of the tubes are connected to an unillustrated pressurized fluid supply source. FIG. 5 shows the cylinder apparatus 10 in an unclamping state, while FIG. 6 shows the cylinder apparatus 10 in a clamping state. Description will be made below by using the unclamping state shown in FIG. 5 as an initial position.

After the foregoing preparatory operation is completed, the unillustrated pressurized fluid supply source is operated for the cylinder apparatus 10 which provides the initial position shown in FIG. 5 so that the pressurized fluid is introduced into the cylinder chamber 38a through one of the pressurized fluid inlet/outlet ports 52a. The piston 28 is pressed in accordance with the action of the pressurized fluid introduced into the cylinder chamber 38a, and the piston 28 is raised along the cylinder chamber 38a. During this process, the linear accuracy of the piston 28 and the piston rod 40 is maintained owing to the guiding function effected by the wear ring 42 which is installed to the outer circumferential surface of the piston 28 and the bush 58 which surrounds the outer circumferential surface of the piston rod 40.

The linear motion of the piston 28 is transmitted to the toggle link mechanism 60 via the piston rod 40, and it is converted into the rotational motion of the arm 22.

That is, the linear motion (upward movement) of the piston 28 effects the force to upwardly press the link plates 72 which are rotatably coupled to the fee end of the piston rod 40. The pressing force acting on the link plates 72 allows the link plates 72 to rotate by a predetermined angle about the first pin member 64 as the support point, and the force allows the support lever 70 to rotate in a direction of an arrow A about the second pin member 68 as the support point. Therefore, the arm 22 is rotated by a predetermined angle in a direction of an arrow B about the support lever 70 as the support point.

Accordingly, the arm 22 arrives at a previously and initially set clamping position in accordance with the rotating action of the arm 22. Thus, the clamping state for a workpiece W is achieved as shown in FIG. 6. In this state, the axis C of the piston rod 40 is substantially parallel to the axis D of the support lever 70. Moreover, the rollers 66a, 66b, which are coupled to the free end of the piston rod 40, are engaged with the reaction force-

receiving plates 106a, 106b.

In the clamping state, as shown in FIG. 11, the output of the cylinder apparatus 10 (pressing force of the piston 28) is transmitted to the support lever 70 in an enhanced manner in accordance with the action of the toggle link mechanism 60. A rotational torque, which is proportional to a length E of the support lever 70, is generated in a direction of an arrow F. Therefore, the arm 22 can reliably clamp the workpiece W in accordance with the action of the rotational torque.

When the workpiece W is clamped by the arm 22, a reaction force H in a direction opposite to the clamping force of the arm 22 is applied to the arm 22 as shown in FIG. 11. The reaction force H is transmitted to the toggle link mechanism 60 via the arm 22. The reaction force H acts as a force to rotate the support lever 70 in a direction of an arrow G about the second pin member 68 as the support point in the toggle link mechanism 60. The force, which is transmitted via the third pin member 76, acts as a force to press the link plates 72 and the rollers 66a, 66b in a direction of an arrow I.

Therefore, the reaction force H, which is applied when the workpiece W is clamped, finally acts as the force to press the rollers 66a, 66b in the direction of the arrow I. However, in this embodiment, the pressing force in the direction of the arrow I, which acts on the rollers 66a, 66b, is held by the reaction force-receiving plates 106a, 106b provided on the inner wall surfaces of the body 14. Accordingly, the reaction force H is absorbed by the reaction force-receiving plates 106a, 106b.

On the other hand, in the state shown in FIG. 6, the pressurized fluid is supplied to the pressurized fluid inlet/outlet port 50 in accordance with a switching action of an unillustrated directional control valve so that the piston 28 is lowered. Accordingly, the support lever 70 is rotated in a direction opposite to the foregoing by the aid of the link plates 72 in accordance with the downward movement of the piston rod 40. Thus, the arm 22 is rotated in a direction to make separation from the workpiece W. As a result, the workpiece W is released from the clamping state, and the cylinder apparatus 10 is restored to the initial position shown in FIG. 5.

In this embodiment, the reaction force H, which is generated when the workpiece W is clamped, is absorbed by the reaction force-receiving plates 106a, 106b provided on the inner wall surfaces of the body 14. Moreover, the reaction force-receiving plates 106a, 106b are detachably attached by the aid of the screw members. Accordingly, when the reaction force-receiving plates 106a, 106b wear out, they can be conveniently replaced with new reaction force-receiving plates 106a, 106b.

Therefore, unlike the conventional technique, this embodiment does not adopt the arrangement in which the reaction force H is received by the guide groove formed on the inner wall surface of the casing. Accordingly, it is possible to avoid occurrence of any backlash and rotate the arm 22 in a stable manner. As a result, it is possible to avoid the decrease of the clamping force of the arm 22 for the workpiece W, which would be otherwise caused by the backlash.

In this embodiment, it is possible to conveniently perform maintenance by removing the cover members 16a, 16b which are fastened by the screws to the openings 12a, 12b of the body 14.

Next, a cylinder apparatus 10a according to a second embodiment of the present invention is shown in FIG. 12.

In the cylinder apparatus 10a, only one bearing section 20a, which is formed on the support lever 70, is exposed to the outside from the cover member 16a. A thin type arm 22c having an L-shaped configuration is connected to the bearing section 20a. The thin type arm 22c connected as described above is advantageous in that the cylinder apparatus 10a can be installed in a narrow width space.

Next, a cylinder apparatus 110 according to a third embodiment of the present invention is shown in FIGs. 13 to 18. The same constitutive elements as those of the cylinder apparatuses 10, 10a shown in FIGs. 1 and 12 are designated by the same reference numerals, detailed explanation of which will be omitted.

The cylinder apparatus 110 is characterized in that the thin type arm 22c, which is provided for the cylinder apparatus 10a shown in FIG. 12, can be held in an exchangeable manner on the right or left side of the body 14 by changing the assembling direction of a support lever 112 provided in the body 14 (see FIG. 15).

That is, as shown in FIG. 14, the support lever 112, which is rotatably supported on the body 14 about the support point of a second pin member 114, is provided in the body 14 for constructing the cylinder apparatus 110. A bearing section 116 having a square-shaped cross section is provided at one end of the support lever 112 so that it protrudes toward the outside through the hole 84 of one of the cover members 16a.

Reference numeral 118 indicates a projection which is coupled to the pair of link plates 72 by the aid of the third pin member 76 rotatably supported thereon. Reference numeral 120 indicates a pair of step sections to be inserted and fitted to the circular holes 84 of the cover members 16a, 16b. Reference numeral 122 indicates a depression which is formed between the pair of step sections 120 and which is fitted to the protrusion 80 of the body 14.

As shown in FIG. 15, a screw hole 124 having a tapered cross section is formed at a central portion of the bearing section 116 of the support lever 112. The bearing section 116 is formed with slits 126 which communicate with the screw hole 124 in the diagonal directions from four corners and which extend by a predetermined length along the axial direction of the bearing section 116.

A screw plug 128 having a tapered cross section is fitted to the screw hole 124 of the bearing section 116. As shown in FIGs. 17A and 17B, the width of the bear-

ing section 116 is increased outwardly by the aid of the slits 126 by increasing the screwing amount of the screw plug 128. As a result, the arm 22c can be detachably coupled by the aid of the bearing section 116.

Explanation will now be made for the operation for reassembling the cylinder apparatus 110 shown in FIG. 13 in which the arm 22c is held on the right side surface of the body 14 (hereinafter referred to as "right arm type cylinder apparatus") into the cylinder apparatus 110 shown in FIG. 18 in which the arm 22c is held on the left side surface of the body 14 (hereinafter referred to as "left arm type cylinder apparatus").

At first, as shown in FIG. 16A, the screw plug 128, which has been screwed into the screw hole 124 of the bearing section 116 of the right arm type cylinder apparatus 110, is loosened. Thus, the width of the bearing section 116 is decreased inwardly. Accordingly, the arm 22c, which has been held by the bearing section 116, is removed.

Subsequently, as shown in FIG. 16B, the pair of cover members 16a, 16b, which have been fastened by screws to the mutually opposing upper portions of the body 14, are removed respectively. After that, the second pin member 114, which has been inserted into the hole, is extracted, and the support lever 112 is separated from the protrusion 80 of the body 14 through the depression 122. Thus, the support lever 112 can be removed from the body 14. Reference numeral 130 indicates a clip for fastening the second pin member 114 to the support lever 112.

The support lever 112, which has been removed from the body 14 as described above, is rotated by 180 degrees in a direction opposite to the foregoing direction. After that, as shown in FIG. 16C, the support lever 112 is incorporated into the inside of the body 14 so that the bearing section 116 is located on the left surface side of the body 14.

That is, the second pin member 114 is inserted into the hole of the support lever 112, and the depression 122 is used to fit the support lever 112 to the protrusion 80 of the body 14. The cover members 16a, 16b are installed to the body 14 respectively. Thus, the left arm type cylinder apparatus 110 is completed as shown in FIG. 18.

It is a matter of course that when the left arm type cylinder apparatus 110 is reassembled into the right arm type cylinder apparatus 110, an assembling operation may be performed in an order opposite to that described above.

As described above, according to the cylinder apparatus 110 concerning this embodiment, it is possible to alternately and conveniently reassemble the right arm type cylinder apparatus 110 into the left arm type cylinder apparatus 110. Therefore, it is unnecessary to prepare two cylinder apparatuses of the right arm type and the left arm type. The user can obtain the desired cylinder apparatus 110 of the right arm type or the left arm type by appropriately reassembling the apparatus depending on the environment of use.

In each of the cylinder apparatuses 10, 10a, and 110 according to the first, second, and third embodiments, respectively, the body 14 is integrally formed. However, the present invention is not limited to these embodiments, the body 14 may be divided into a first body 14a and a second body 14b, as shown in FIG. 19.

Claims

1. A cylinder apparatus comprising:

   a body (14, 14a, 14b) having a flat rectangular parallelepiped shape;
   a cylinder unit (18) connected to one end of said body (14, 14a, 14b), for accommodating a piston (28) which is reciprocatable along a cylinder chamber (38, 38a);
   a toggle link mechanism (60) provided in said body (14, 14a, 14b), for converting linear motion of a piston rod (40) connected to said piston (28) into rotational motion; and
   an arm (22, 22a to 22c) connected to said toggle link mechanism (60), for making rotation by a predetermined angle in accordance with a driving action of said cylinder unit (18), wherein;
   a reaction force-absorbing member (106a, 106b) for absorbing reaction force (H) applied when a workpiece (W) is clamped is detachably provided in said body (14, 14a, 14b).

2. The cylinder apparatus according to claim 1, wherein said reaction force-absorbing member is composed of a reaction force-receiving plate (106a, 106b) fastened by screws to an upper portion in an opening (12a, 12b) of said body (14, 14a, 14b), and said reaction force-receiving plate (106a, 106b) is provided to engage with a roller (66a, 66b) connected to a free end of said piston rod (40).

3. The cylinder apparatus according to claim 1, wherein a pair of mutually opposing openings (12a, 12b) are formed in said body (14, 14a, 14b), and said body (14, 14a, 14b) is detachably provided with a pair of cover members (16a, 16b) for closing said openings (12a, 12b) respectively.

4. The cylinder apparatus according to claim 1, wherein said toggle link mechanism (60) comprises rollers (66a, 66b) connected to a free end of said piston rod (40) via a first pin member (64), a support lever (70, 112) supported by a second pin member (68) rotatably with respect to said body (14, 14a, 14b), and link plates (72) for linking said free end of said piston rod (40) to said support lever (70, 112).

5. The cylinder apparatus according to claim 4, wherein a pair of bearing sections (20a, 20b), which protrude outwardly through holes (84) of a pair of cover members (16a, 16b) and which are coupled to said arm (22, 22a, 22b), are formed at both ends of said support lever (70).

6. The cylinder apparatus according to claim 4, wherein a bearing section (116), which protrudes outwardly through a hole (84) of a cover member (16a, 16) and which is coupled to said arm (22c), is formed at one end of said support lever (112).

7. The cylinder apparatus according to claim 1, wherein said cylinder unit (18) comprises a cylinder tube (36) composed of a cylinder having an elliptic cross section, said piston (28) having a shape which corresponds to the cross section of said cylinder tube (36), and an end block (34) for closing one end of said cylinder tube (36).

8. The cylinder apparatus according to claim 6, wherein said arm (22c) is selectively provided on one side surface or the other side surface of said body (14, 14a, 14b), said side surfaces being mutually opposed to one another, by removing said support lever (112) from said body (14, 14a, 14b), rotating said support lever (112) by 180 degrees, and reassembling said support lever (112) in an opposite direction.

9. The cylinder apparatus according to claim 5, wherein said arm (22) comprises a main arm body (88) held by said pair of bearing sections (20a, 20b) protruding outwardly from side surfaces of said body (14, 14a, 14b) respectively, and a clamp section (90) for making abutment against said workpiece (W) to press said workpiece (W), and wherein said clamp section (90) is provided at a central portion of said main arm body (88).

10. The cylinder apparatus according to claim 5, wherein said arm (22a, 22b) comprises a main arm body (88) held by said pair of bearing sections (20a, 20b) protruding outwardly from side surfaces of said body (14, 14a, 14b) respectively, and a clamp section (90) for making abutment against said workpiece (W) to press said workpiece (W), and wherein said clamp section (90) is provided on any one of sides deviated from a central portion of said main arm body (88).

FIG.1

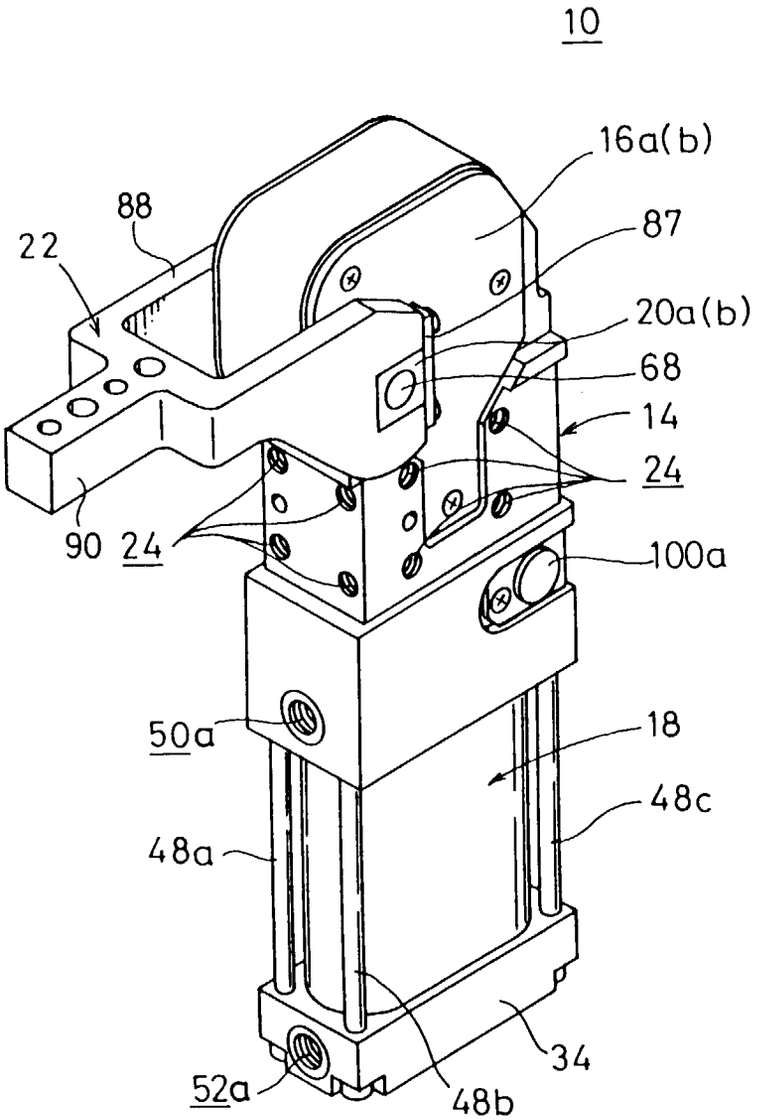
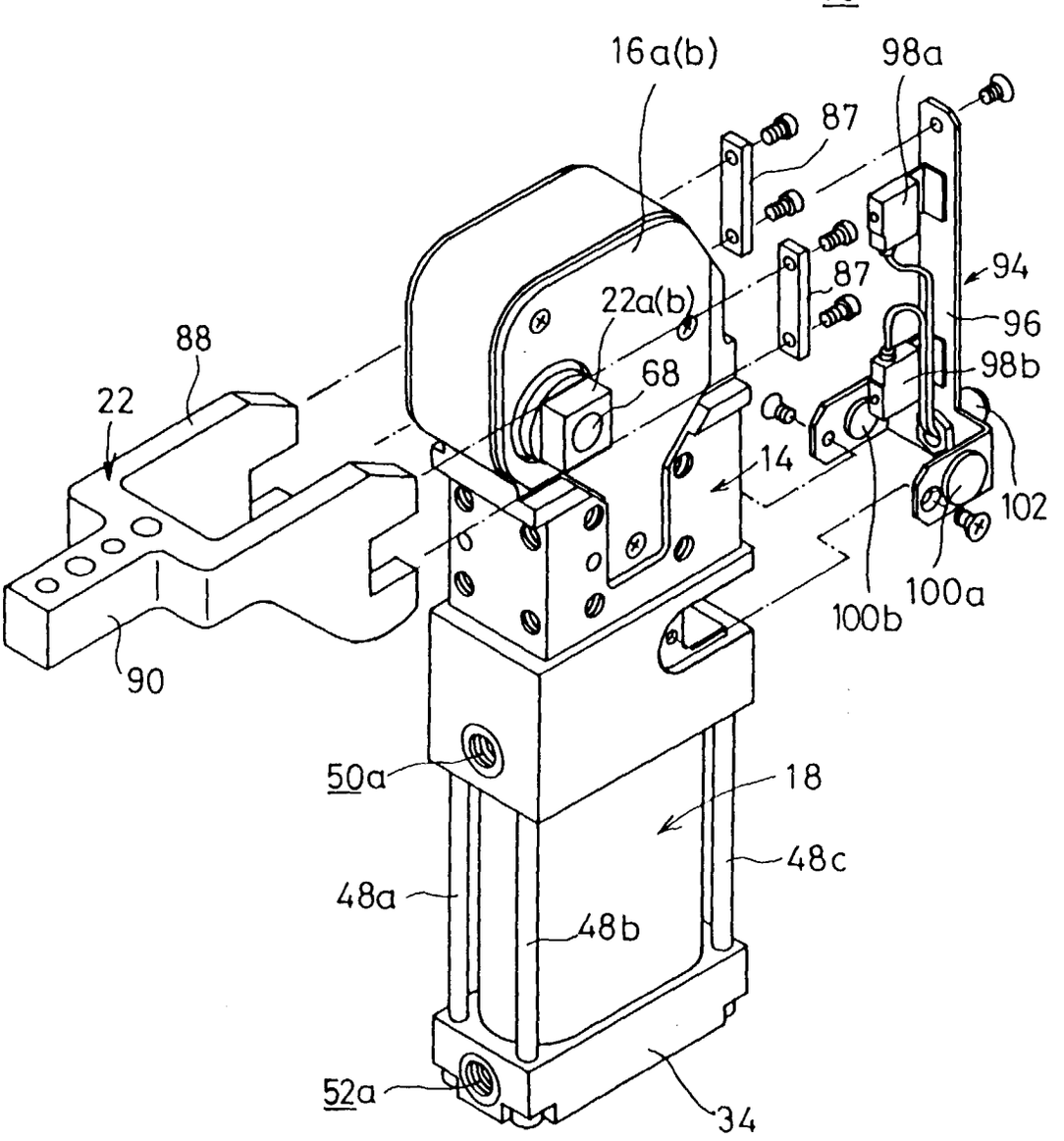


FIG.2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94
22a(b)
96
88
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48a
48b
52a
34

FIG.3

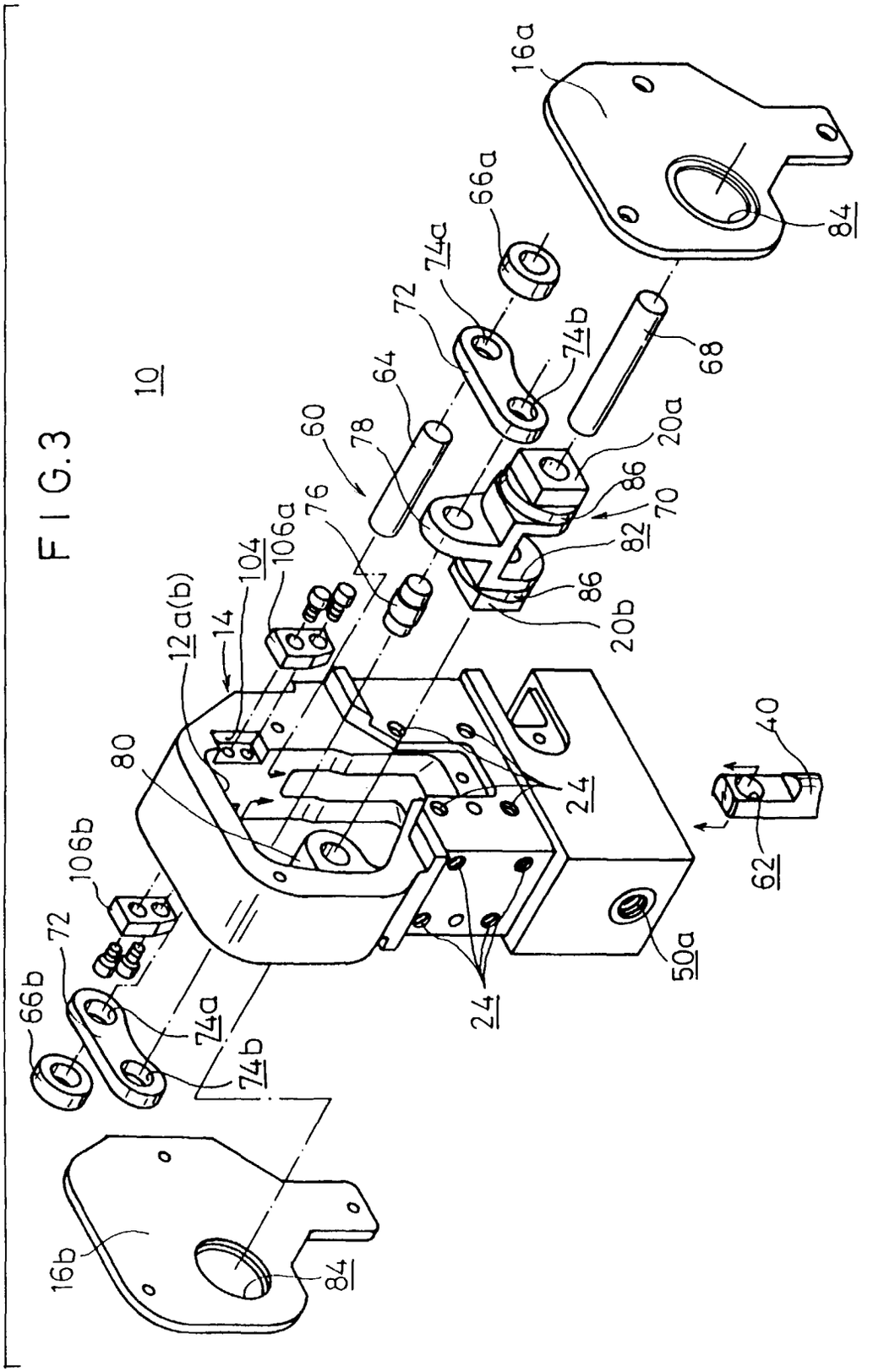
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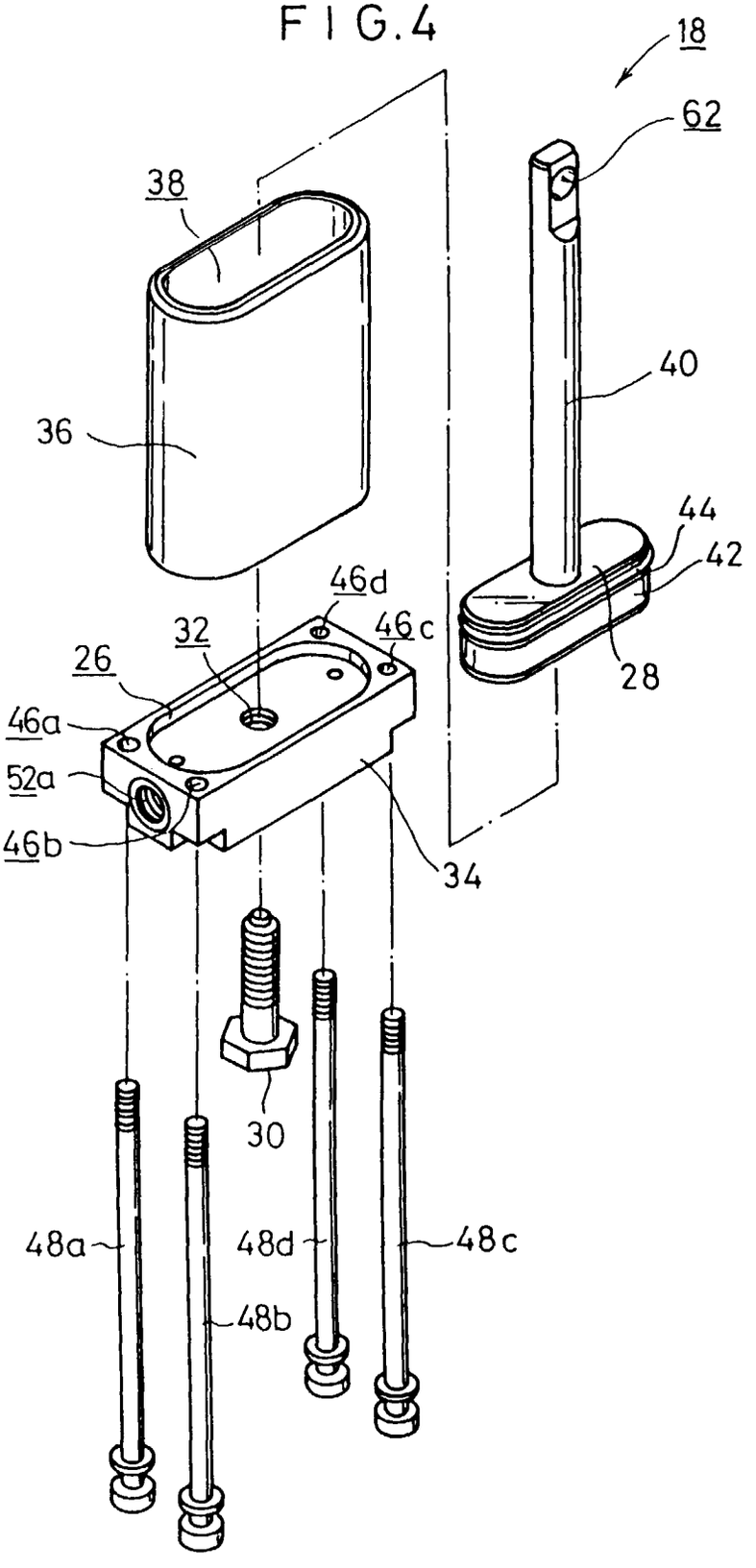
FIG.4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44
42
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46c
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26
28
46a
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46b
34
30
48a
48d
48c
48b

FIG.5

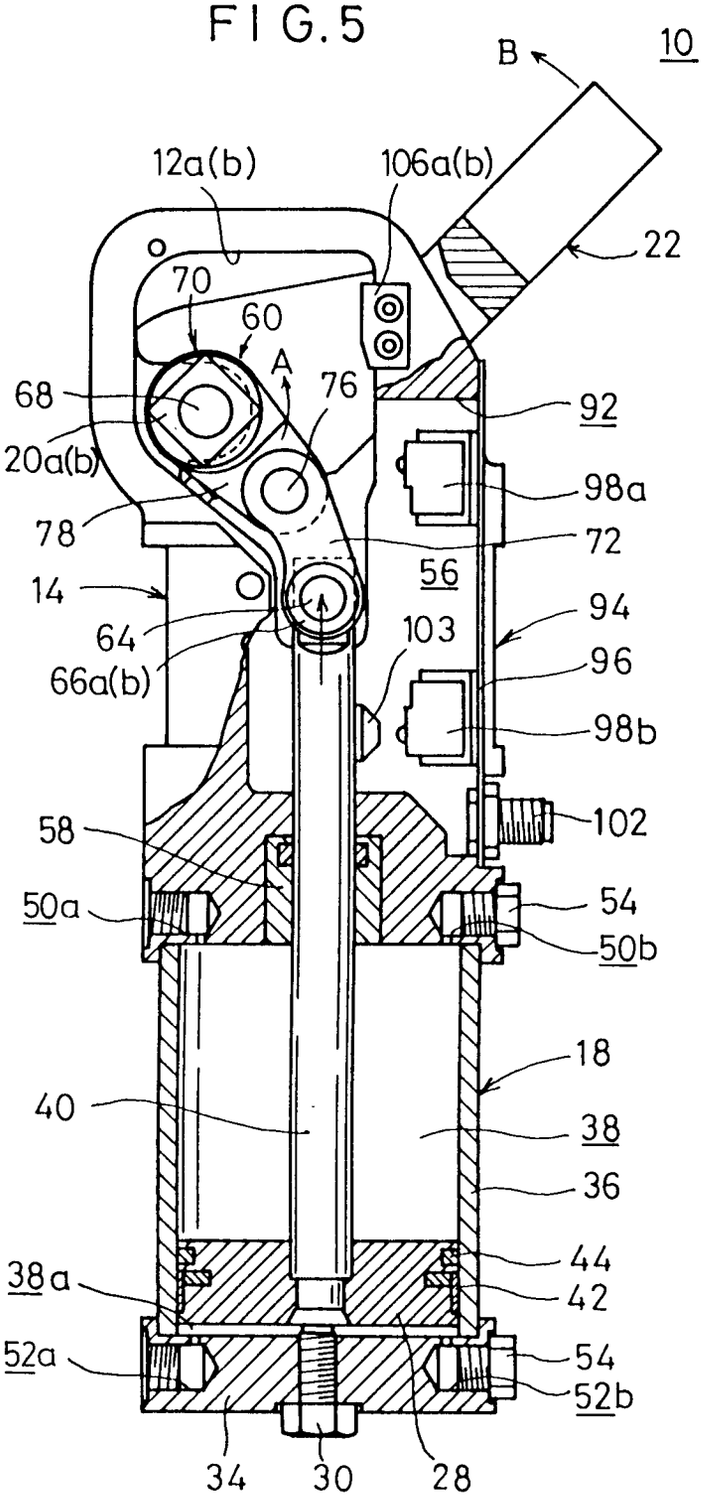

B
10
12a(b)
106a(b)
22
70
60
A
76
68
92
20a(b)
98a
78
72
56
14
94
64
103
96
66a(b)
98b
102
58
50a
54
50b
18
40
38
36
44
38a
42
52a
54
52b
34
30
28

FIG. 6

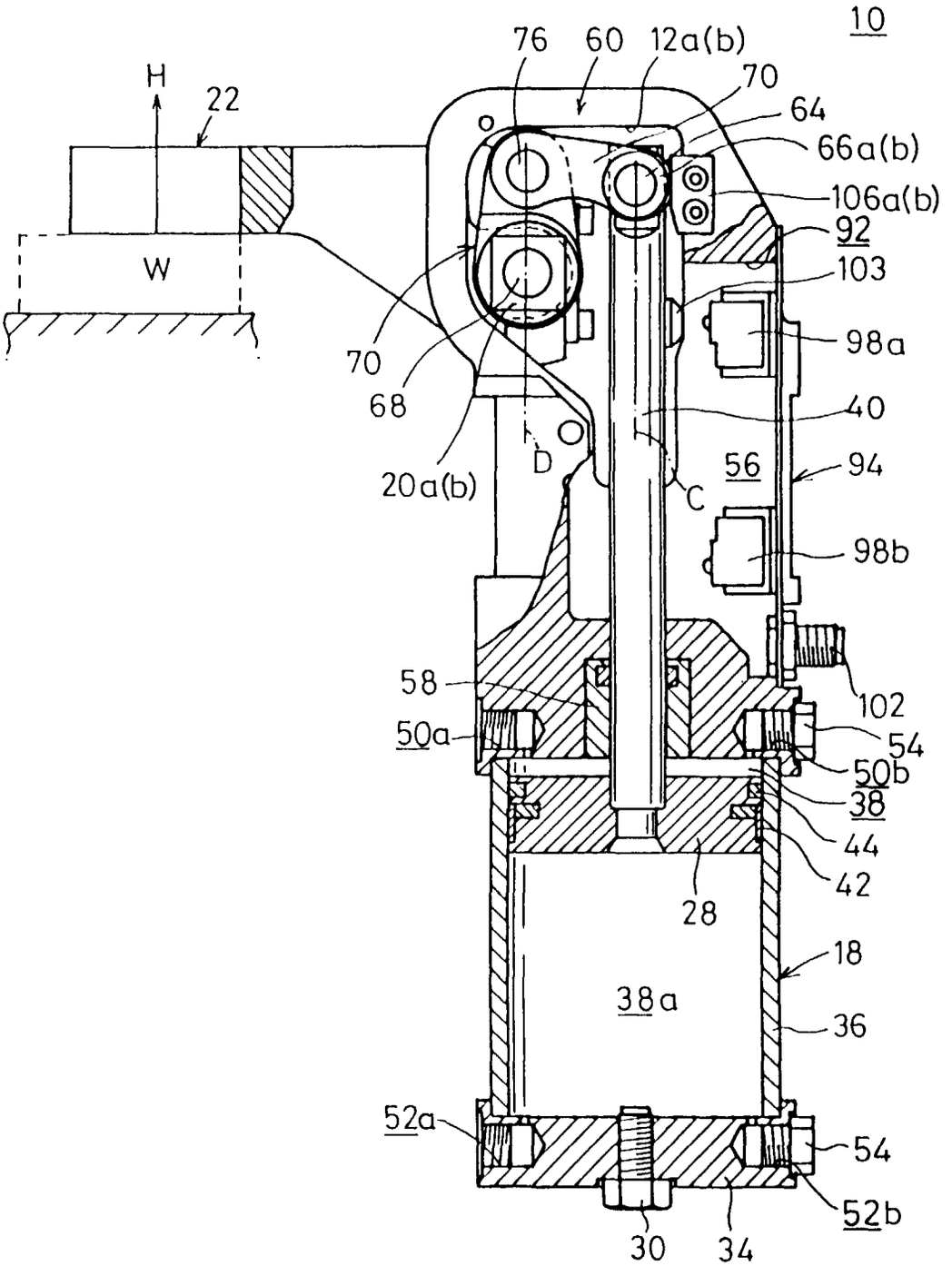

10
76
60
12a(b)
70
64
66a(b)
106a(b)
92
103
98a
40
94
56
98b
102
54
50b
38
44
42
28
18
38a
36
52b
54
52a
30
34
H
22
W
70
68
20a(b)
D
C
58
50a

FIG.7

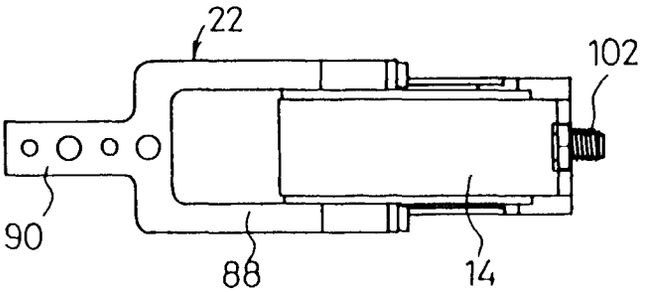


FIG.8

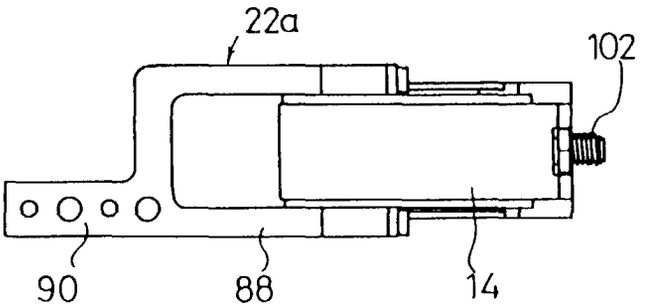


FIG.9

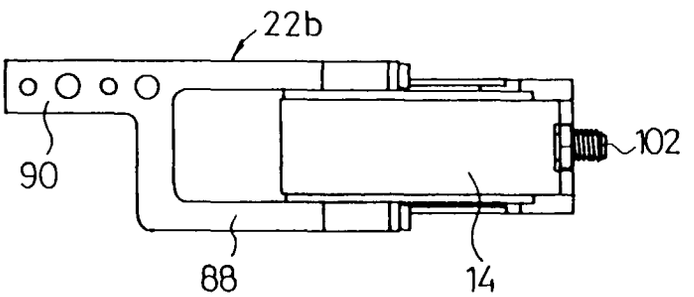


FIG.10A

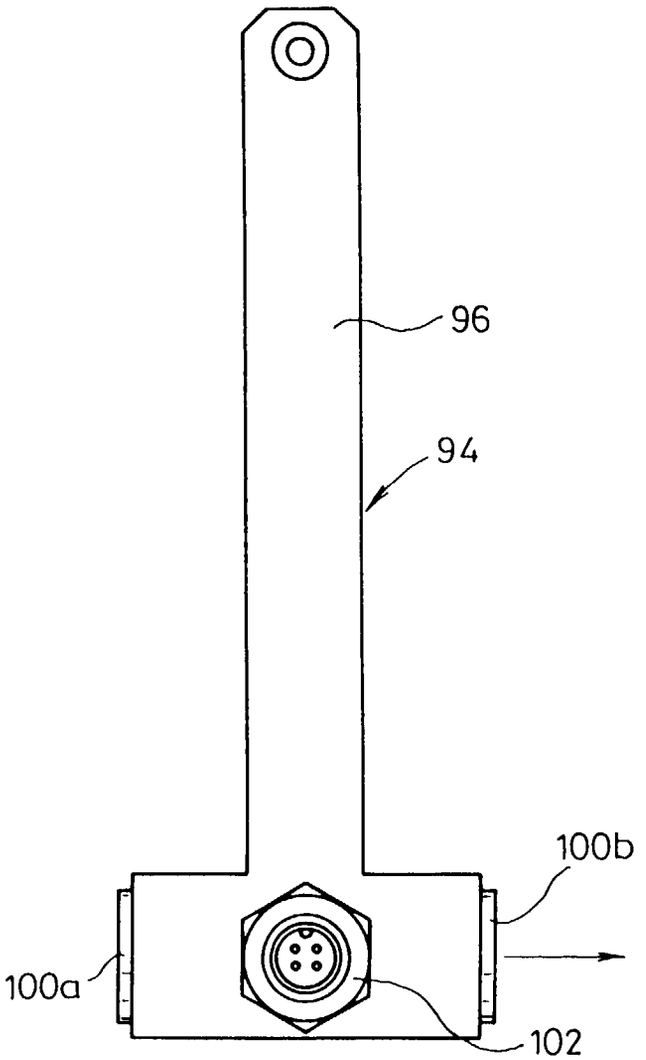


FIG.10B

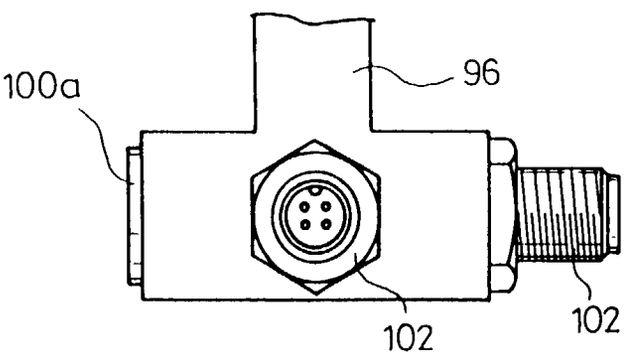


FIG.11

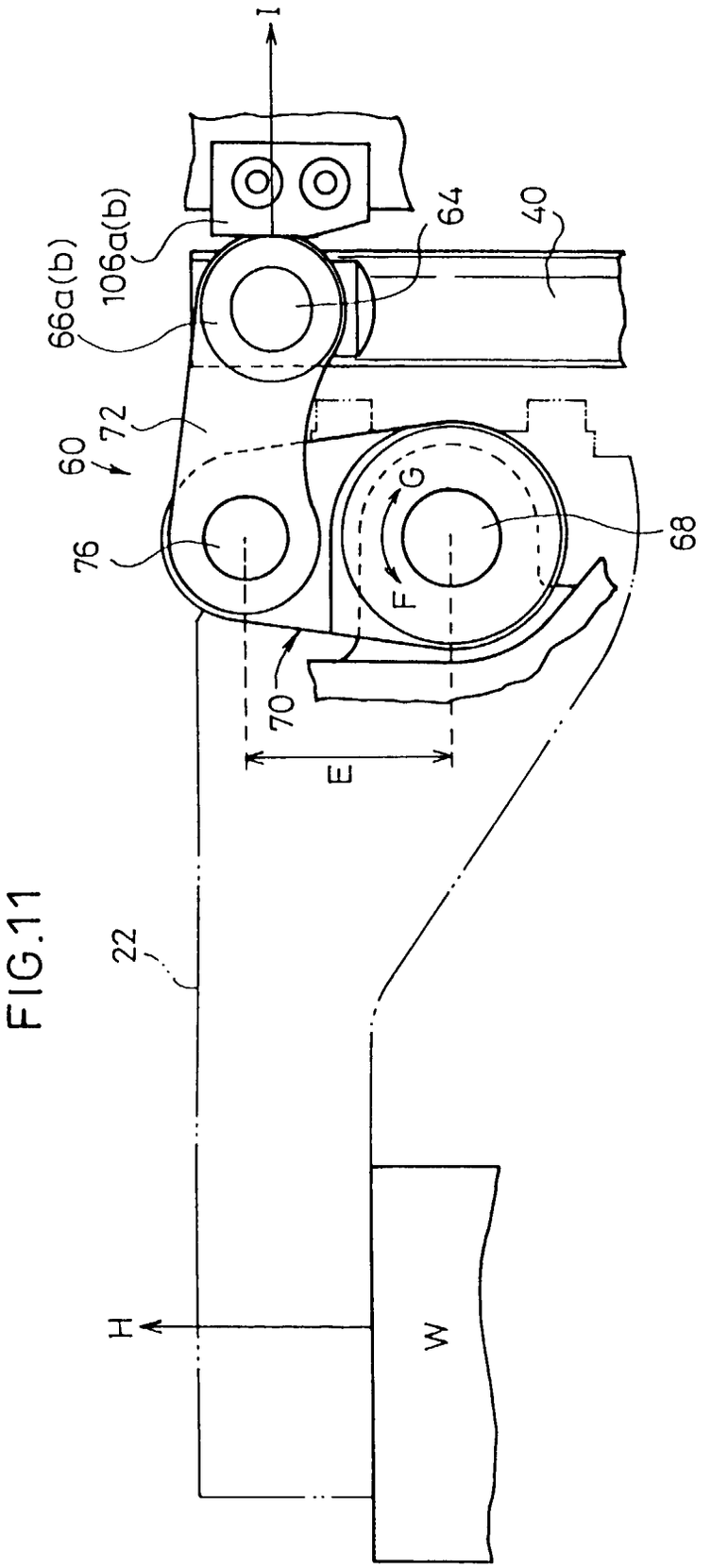


FIG.12

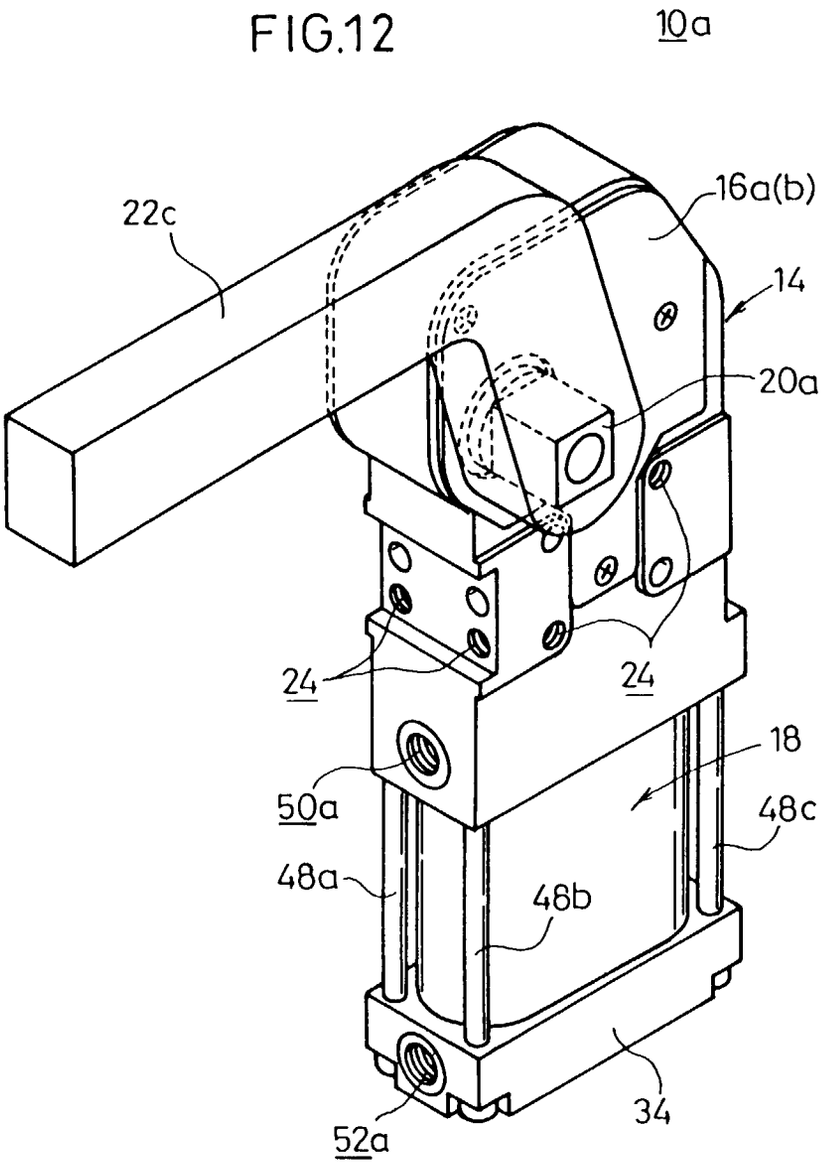


FIG.13

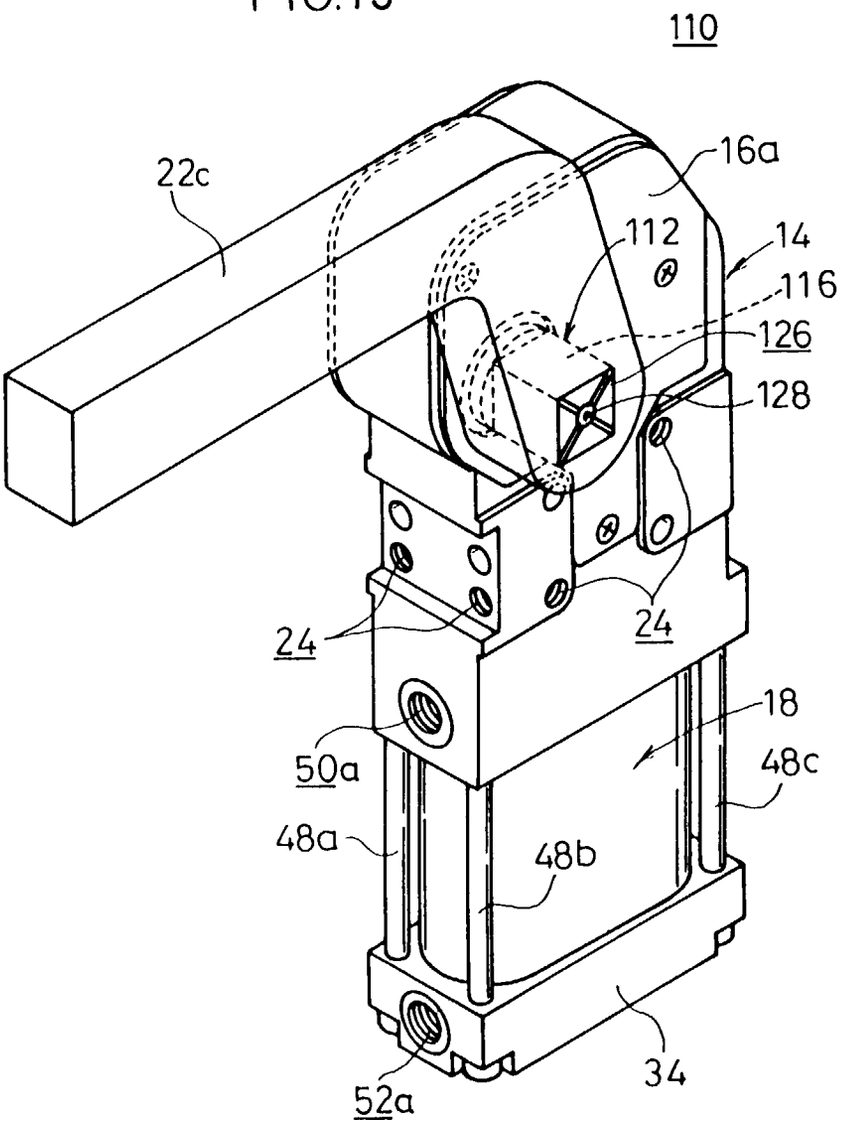


FIG.14

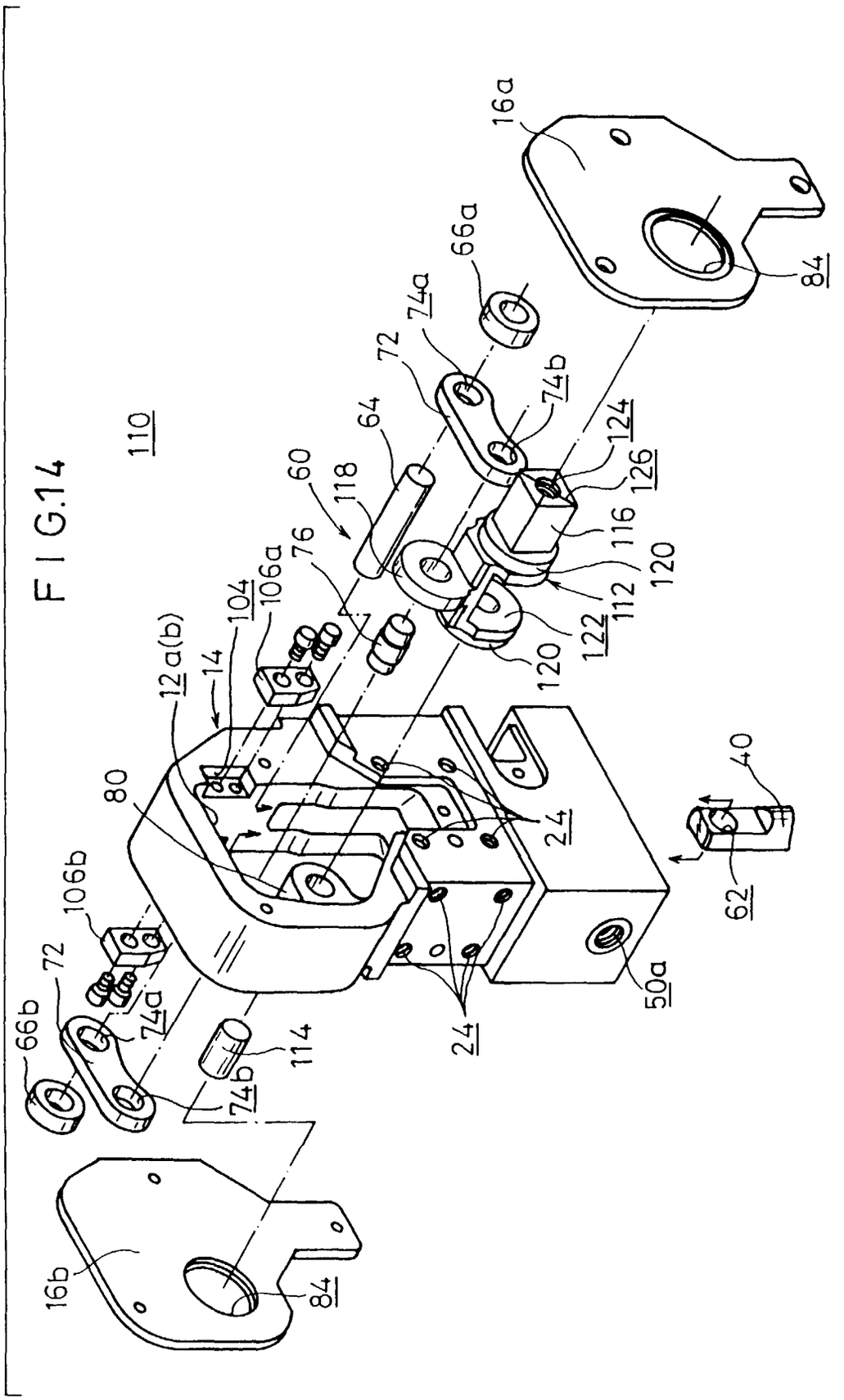

110
16a
84
66a
74a
72
74b
64
60
118
124
126
116
120
112
122
120
76
106a
104
12a(b)
14
80
106b
72
66b
74a
74b
114
16b
84
24
24
40
62
50a

FIG.15

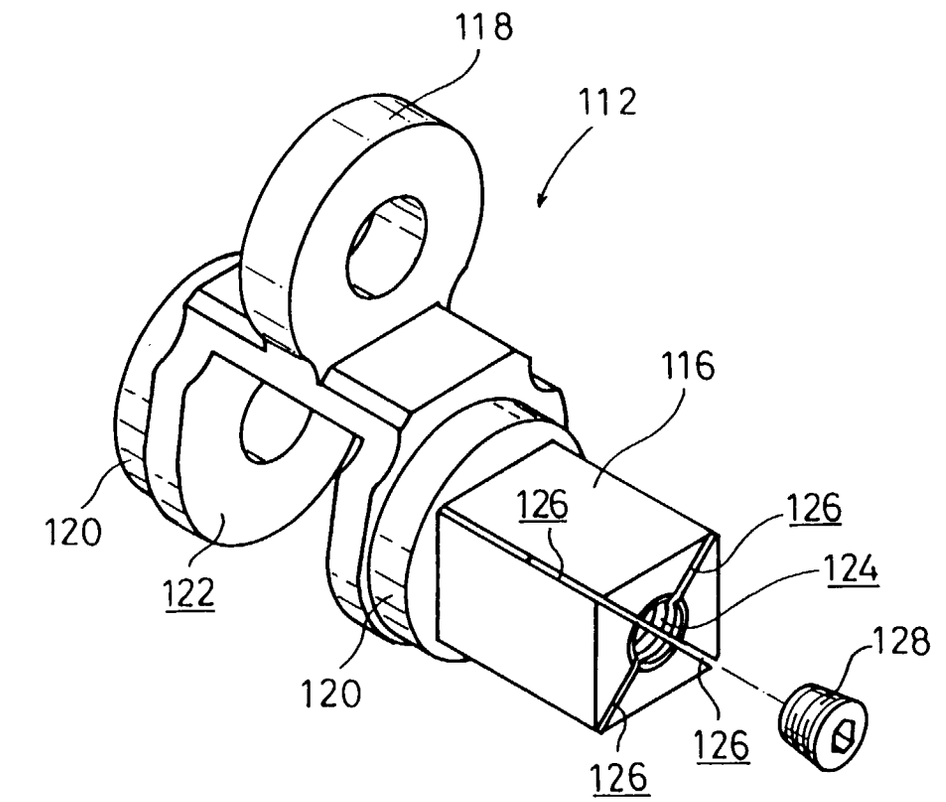


FIG.16C

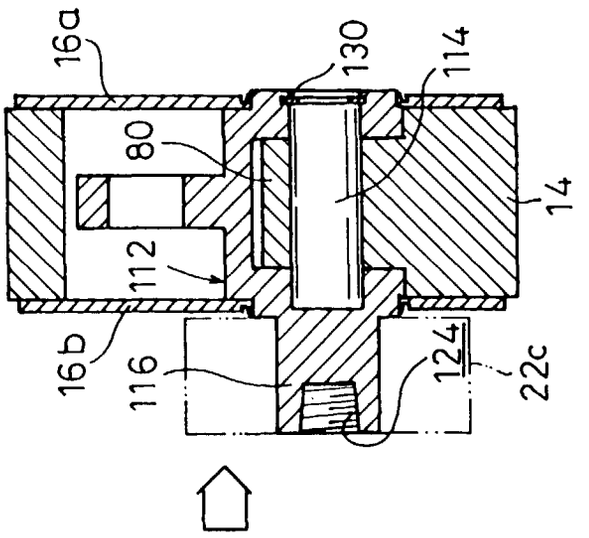


FIG.16B

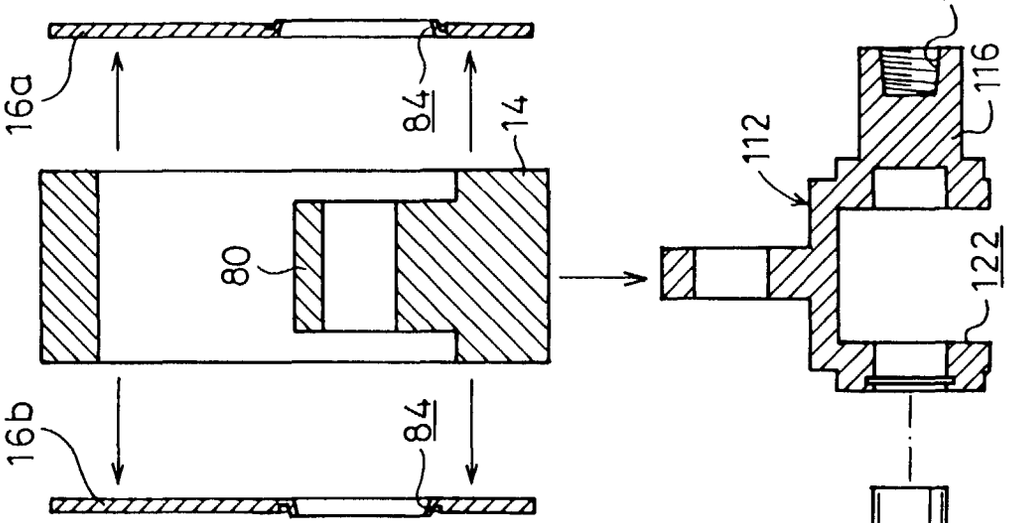


FIG.16A

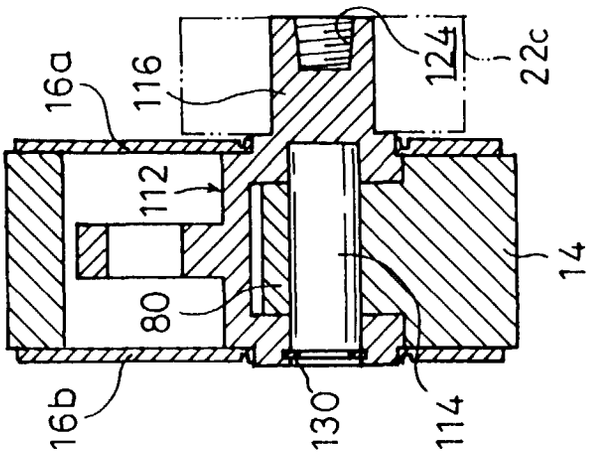


FIG.17A

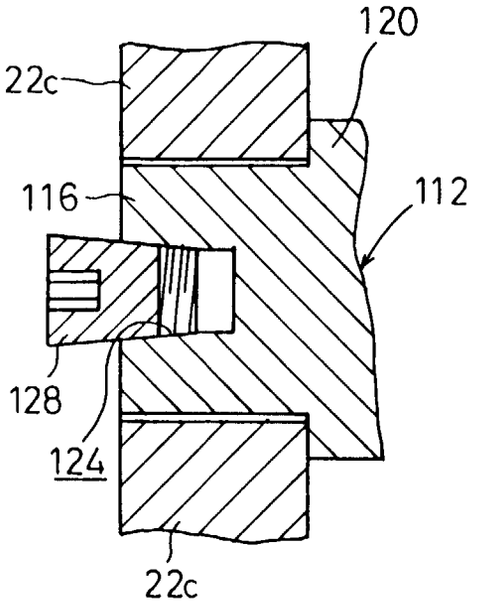


FIG.17B

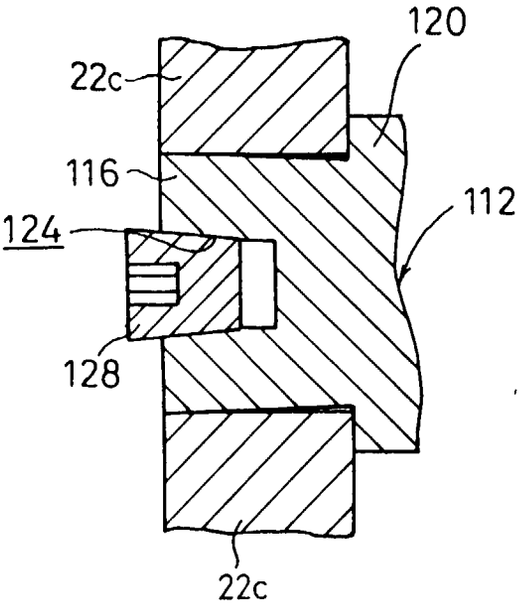


FIG.18

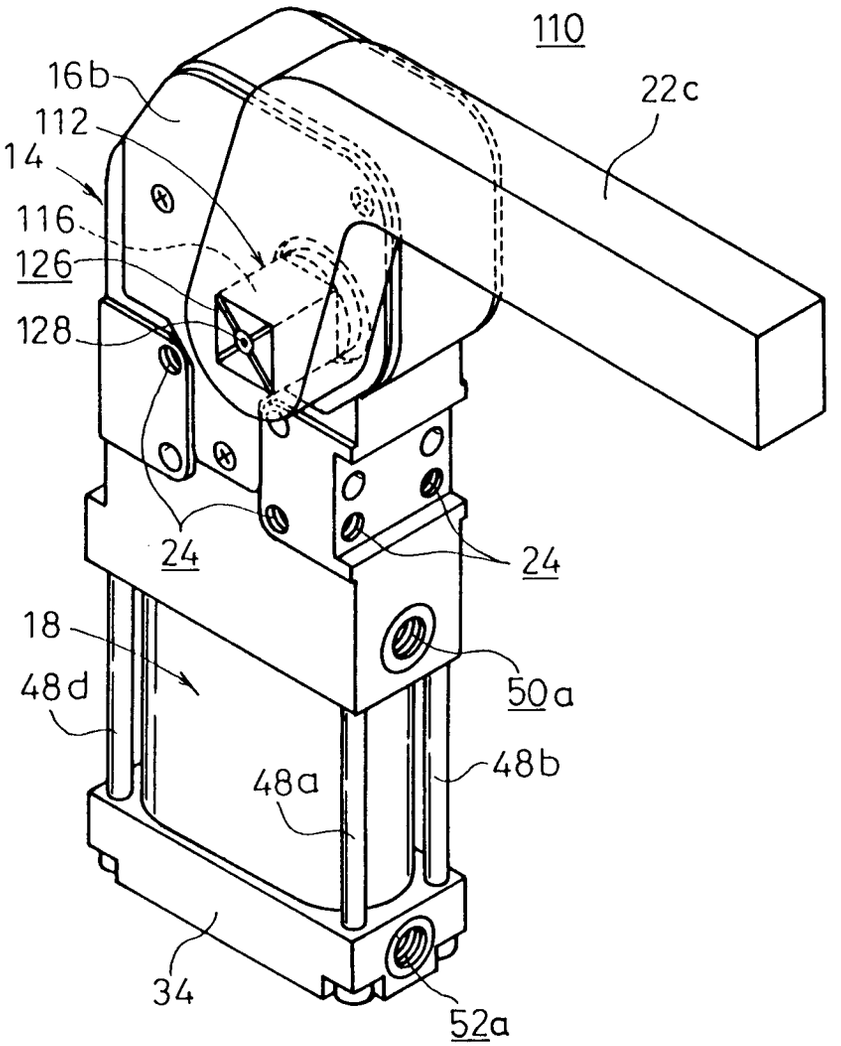
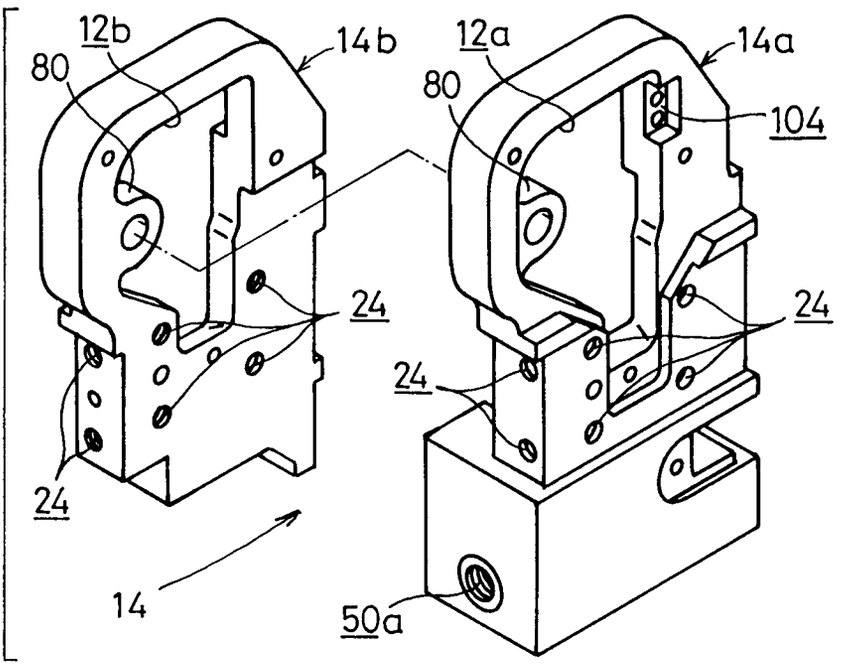

110
16b
112
14
116
126
128
22c
24
24
18
48d
50a
48b
48a
34
52a

FIG.19


12b
14b
80
12a
14a
80
104
24
24
24
24
24
14
50a